Structural Health Monitoring utilizing an Automated Optical Fiber Switching Network

Completed Technology Project (2017 - 2018)

Project Introduction

To incorporate the (1x24) optical switches into the FOSS unit architecture, research will be conducted into establishing communication and synchronization between the optical switches, peripheral sensors and accompanying data acquisition system, sweeping laser and the data management system. # The optical switches will cycle through sensing fibers periodically until an event is triggered. The use of peripheral sensors will provide feedback to the optical switches to intelligently interrogate sensing fibers of interest temporarily, then resume periodic switching. The use of optical switches will also allow for a redundant interrogation path by allowing interrogation from two ends of a sensing fiber. In the event where a sensing fiber is damaged, the fiber could be examined from two ends to recover data that may otherwise have been lost. Redundancy may be critical for certain research vehicles, and is currently unobtainable with the current system architecture.

Anticipated Benefits

This research also demonstrated the ability to greatly increase sensor counts, and in turn, sensing area of the Armstrong FOSS units. Increase sensing area is highly desirable since damage from MMOD impacts can occur anywhere over a surface, and the resulting damage to the TPS can cause voids in the surface of any size. With all the variability of impact locations and size, a full surface monitoring system could help detect these changes to the TPS. These increase in sensor counts can be achieved with minimal weight and size penalties. The main trade off is the reduction in data acquisition speed. While the switch is changing position, the FOSS unit cannot make measurements. Also, depending on the number of switch positions being implemented, it

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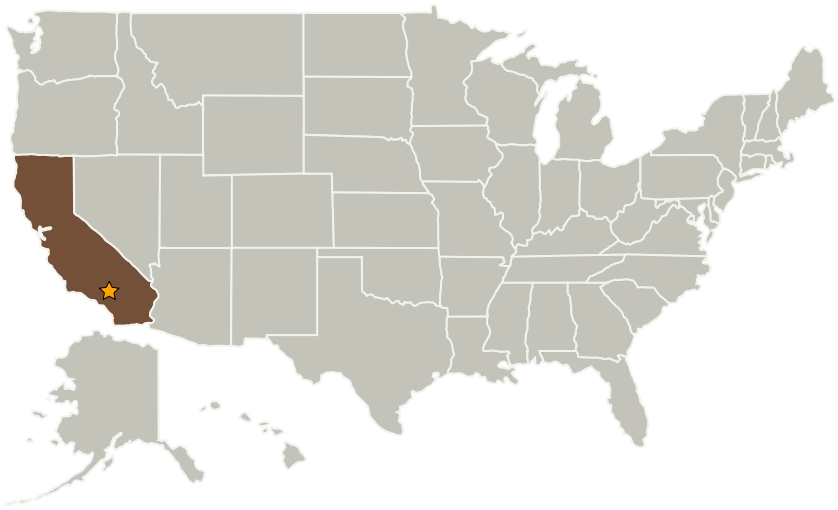
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California

Primary U.S. Work Locations
California

Project Transitions

October 2017: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Center Innovation Fund: AFRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

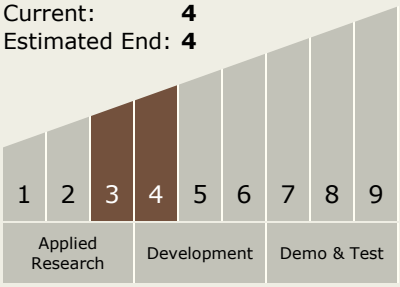
David F Voracek

Principal Investigator:

Francisco Pena

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Center Innovation Fund: AFRC CIF

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September 2018: Closed out

Closeout Summary: Through this research effort, a FOSS unit has been modified to interface with a 1x24 optical switch. A bench top demonstration was developed to show the full system integration of the FOSS, optical switches and peripheral sensors (accelerometers). Eight Alumina Tiles, used as a thermal protection system, were instrumented with serpentine patterns of the fiber optic sensors. Each of the Alumina Tiles were designed with removable plugs on the heated side to simulate damage to the tile from a micrometeoroids and orbital debris (MMOD) impact. Heat was applied to the tile and the fiber optic sensors on the opposite side monitored the temperature and was used to detect high thermal gradients where the plugs were removed. This demonstrated the feasibility of utilizing distributed fiber optic sensors for assessing the health of a thermal protection system by monitoring the efficiency of the state of the tiles.

Project Website:

https://www.nasa.gov/directorates/spacetech/innovation_fund/index.html#.VC

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.3 Thermal Protection Components and Systems
    - TX14.3.5 Thermal Protection System Instrumentation

Target Destination

Earth